VOL. 14 PARTS 1 - 11

TRANSACTIONS

OF THE

SOCIETY FOR BRITISH ENTOMOLOGY

World List abbreviation: *Trans. Soc. Brit. Ent.*

CONTENTS.

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TRANSACTIONS OF THE SOCIETY FOR BRITISH ENTOMOLOGY

VOL. 14 APRIL 1960 PART 1

The State of Our Knowledge of the Systematics of the Hymenoptera Parasitica,

with particular reference to the British fauna*

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In Western European countries the state of our knowledge of the Hymenoptera Parasitica is very imperfectly appreciated. An expert on some of the parasitic Hymenoptera is commonly expected to be able to name a miscellaneous collection as readily as a competent systematist can name all but the more difficult groups of British beetles. The state of our knowledge of the two groups is, however, entirely different. The author would not wish to imply that the systematics of Coleoptera are easy; but he found, when first developing as a systematist, that he could name the majority of British beetles encountered. A professional or good amateur who has specialised on British beetles can name nearly all species. By contrast, in the Ichneumonidae, which is the most worked family of parasitic Hymenoptera in Europe, one would not expect to be able to name more than about two-thirds of the specimens from an average miscellaneous collection, and the majority of these not very readily. Some specimens can be named reasonably readily, and others with greater difficulty. In the most difficult and least worked sections, one does not gladly attempt the determination of a single caught specimen, especially if it is a male, for several hours' study of it would probably bring no satisfactory result. The situation in the Braconidae is about as bad, and in the Chalcidoidea and Proctotrupoidea, at least until recently, has been decidedly worse.

The corollary of this is revealed by modern intensive studies made on the more conspicuous sections. The most worked subfamily of the Ichneumonidae in Europe is the Ichneumoninae. The British species have recently been studied by J. F. Perkins

*This paper, in slightly abbreviated form, was given as the Presidential Address to the Eleventh Congress of British Entomologists, organised by the Society for British Entomology, held in Oxford, 3rd-6th July 1959.

(1953), who has added over 80 to, and subtracted over 60 from, the British list of between 350 and 400 species. It was shown that, although the section was supposedly rather well known, different authors have understood many of the earlier species differently. The great monographers have often compounded their species descriptions from those based on the different species by the different authors. In a few cases, the subtractions were due to insufficiently authenticated or actually disproved records; in some, to plain misdeterminations; in yet others, to listing of definitive Gravenhorst species from records based, correctly or supposedly, on Gravenhorst's varieties of his species, many of which differ specifically from the definitive Gravenhorst species. The additions were due to the recognition of over 60 described species not previously recorded as British, and to the description of about 20 species new to science.

In the smaller group of the Exenterini (=Ctenisçini), Kerrich (1952) found that Holmgren had interpreted as Gravenhorst species, species belonging to different genera. On these different interpretations, Schmiedeknecht had based varieties, which he placed under the original species in its right genus. Ten species were described as new among about 60 treated.

The proportion of new species described in such works is relatively small, compared with similar works on species from outside Europe. It amounts to about 6 per cent. among British Ichneumoninae, and 16 per cent. among Old World, mostly European, Exenterini. This is due to the greater number of authors who have worked the European fauna. Some of the older workers were, indeed, good or even brilliant; others described new species upon colour differences that, in isolation, are of little importance. Although these forms would not now be considered as good species on the basis of the colour character alone, modern study has shown that, in many cases, there are also stable structural differences, and the original names used are, therefore, valid. The higher proportion of new species disclosed by myself, than by Perkins, was due partly to the description of two Far Eastern species, and partly to the recognition of five new species in a genus of singular colour uniformity.

The Diplazoninae is a closely-knit subfamily of Ichneumonids parasitic on hover-flies. The egg of the parasite is laid within the egg of its host. Hatching is delayed, and the adult parasite eventually emerges from the host puparium. The species are brightly colour-marked and are often found on flower-heads or around plants infested with aphids. These insects were special favourites of A. W. Stelfox, who was later joined by B. P. Beirne. Beirne (1941b) published a synopsis of the British species, in which special attention was paid to the terminalia. His total of 56 British species included six described as new to science by Stelfox (1941). Other species had been described a few years earlier in Silesia by Hedwig (1938), thus augmenting the not much larger known European total.

The study of the British Pimplini by Perkins (1941) has enabled the species to be determined with far greater accuracy, but the species had mostly been recorded as British before.

Modern intensive studies in Europe have not been numerous. The papers of Clément on the palaearctic Metopiini (1930) and on the Xoridini *sensu lato* (1938) were a big advance on the literature previously available, and have proved invaluable to the present writer for accurate species determination.

The number of 56 British Diplazoninae may be compared with a total of 36 recorded in a recent study of the species of Japan (Uchida, 1957). It seems likely that, with more collecting, the Japanese total will ultimately surpass the British. In the tropics the species seem much fewer; Balthazar (1954) recorded nine from the Philippines and Seyrig (1934) only two from Madagascar. Both authors include *Diplazon laetatorius* (Fabr.), a species found near human dwellings almost all over the world.

The proportion of new species described in comparable North American works is about 50 per cent. or higher. Thus the numbers of old and new species respectively are as follows in these works: revision of *Exetastes* (Cushman, 1937), 17 to 38; revision of *Cryptus* in a rather wide sense (Pratt, 1945), 13 to 31; revision of Tryphonini (Townes & Townes, 1949), 46 to 55; revision of Metopiinae (Townes & Townes, 1959), 65 to 82.

These numbers may need to be modified when the species are better known on both sides of the Atlantic, particularly the more boreal species, which tend more to be holarctic. A sorted North American collection of Ichneumonidae has a similar appearance to a sorted one from Europe; and I believe it will be found in the majority of cases that the North American representatives of a genus will be rather similar to, but will differ specifically from, the European representatives. It has also to be remembered that American workers have a whole continent to draw upon, whereas their colleagues in western Europe know little of the fauna occurring east of Finland. Very many species do extend from Ireland to Japan; but the faunistic exploration of Siberia will undoubtedly disclose many undescribed species. It has already become clear that the fauna of even the cooler parts of Japan contains elements alien to western Europe.

Turning to the tropical species, it was to be expected that these would be still less known. Heinrich (1934), studying the Ichneumoninae collected by himself and two members of his family in Celebes, obtained the following result: old species, 15; old species but new subspecies, 13; new species, 115. Studying Seyrig's Ichneumoninae from Madagascar he found 8 old and 77 new species, while Seyrig himself (1932) found 12 old and 77 new species in the subfamily Pimplinae. More recently, Benoit (1955a, b), studying some of the better worked sections of the family, recorded 16 old species to 44 new in a general African collection and, curiously, as many as 29 old species to 9 new in the collection of an expedition to the Belgian Congo. When some of the less worked sections are studied, the proportion of new species will surely be larger. In general, the above results accord well with my own experience which is that, except when a collection of parasites of a known economic pest is in question, or a collection made around dwellings, about one species in ten from tropical Asia or Africa can be named. From Australia only a few hundred species are known, and the fauna of tropical America is similarly very little worked. The number of species known from those regions must assuredly be less than a tenth of those present.

For the Braconidae, there are standard works on the species of Great Britain and of Europe. There is a monograph of the species of Japan covering the majority of subfamilies (Watanabe, 1937) and also one for the species of certain subfamilies in the U.S.S.R. (Telenga, 1936, 1955), but modern intensive studies of European genera are still much needed. A revision of the Triaspidini of Czechoslovakia (Snoflák, 1952) revealed 20 old species and 23 new, which compares closely with the 30 old and 34 new found in North America by Martin (1956). Fischer, in studies of some sections of the genus *Opius* in Europe (1957, 1958 a, b, c), treated 17 old species and 30 new. The smaller genera of the Aphidiinae have been studied by Stary (1958). It is hoped that the results of M. de V. Graham's study of the Cheloninae will be available in the not distant future.

The proportion of novelties to be discovered in an obscure species-rich group may be illustrated by the Dacnusinae in which of a *Check List* (Kloet & Hincks, 1945) total of 130 species, exactly half were species described by Nixon (1937, 1943, *et seq.*).

For the species of North America there is no general work, but there is a fine series of revisionary papers on some of the more important genera by Muesebeck. This author treated, in his study of *Apanteles* (1920), 128 old species and 36 new; of *Meteorus* (1923), 18 old species and 13 new; of *Microbracon* (1925), 57 old species and 16 new, and of *Macrocentrus* (1932), 16 old species and 20 new. Apart from the last-mentioned work, these papers revealed an unexpectedly low proportion of new species compared with studies of Ichneumonid genera from the same area. Muesebeck was evidently, and very rightly, far more concerned to systematize the mass of species, reared from Lepidoptera and validated by Ashmead and by Viereck, than to gather in fresh material. The Aphidiinae have been studied by Clyde F. Smith (1944).

There is a general work on some subfamilies of Braconidae of Africa (de Saeger, 1944, 1946, 1948) and one on the species of Madagascar (Granger, 1949) but, as in the Ichneumonidae, the species of Australia and South America are hardly known at all.

The Chalcidoidea have been greatly neglected on account of the extreme paucity of useful general works. The species of even the family Chalcididae have been, until recently, astonishingly little known. The four European species of Chalcidinae have, it is true, been generally understood. But, in the genus *Brachymeria*, Thomson (1875) treated three species for Sweden and three others for France and Germany, and Schmiedeknecht did not specify the number for Europe. In the Haltichellinae, Thomson recorded only two species for Sweden, and Schmiedeknecht (1930) took cognisance of only two for middle Europe. The first author to specialise on this family was Masi. He studied mostly the species of Italy, the Mediterranean region generally, and Africa. Ruschka revised the European species of *Brachymeria* (1922) and found, as now recognised, ten species for middle Europe.

The first good general monograph of the European Chalcididae was issued only seven years ago. The author (Boucek, 1952) justly claimed that, at the time of writing, there was, with the exceptions of *Brachymeria* and *Chalcis,* no key available to the species nor even to the genera. Boucek recognised the same species of Chalcidinae and Brachymeriinae as treated by other authors, but in the subfamily Haltichellinae he gave, for Europe north of the Pyrenees, Mediterranean coastal region and Alpine watershed, a total of 23 species, which contrasted strongly with the two or three species cited in earlier general works. Of these 23 species, eight were new, and several others were species described by Masi and newly recognised as occurring north of the Alps. Boucek's results were largely confirmed by the production, at about the same time, of excellent keys to the Haltichellinae of France by Steffan (1951-53). With these two papers, and a further revision of the *Brachymeria* of the Mediterranean region by Masi (1951), our knowledge of the European species of this family has indeed been transformed within the present decade.

The Perilampidae of Europe have also become relatively well known of recent years through works cited by Kerrich (1958), and there is a paper on the species of North America (Smulyan, 1936). Nikol'skaya is making a further study of the species of the U.S.S.R.

The number of species of British Chalcidoidea may not differ so very greatly from that listed by Kloet & Hincks (1945), on account of the very extensive studies carried out by Francis Walker a century and more ago. Walker collected and described a lot of material, and this greatly inflated the British species list; but modern research on his collection shows that many of his supposed species are no more than forms differing in size, colour, degree of sculpture, wing marking or sex from the type. He had no skill in reading through these differences, such as was possessed in a remarkable degree by C. G. Thomson, who worked in southern Sweden in about the last 40 years of the century. Walker also described long lists of varieties, designated by letters of the Greek alphabet; but it has proved impossible to trace most of these. Their identity is hardly worth the effort of conjecture.

In consequence of this, the deletions of names from the British list, due to placements in synonymy, have recently been outstripping the additions caused by the discovery of fresh species. Thus, the number of British species covered in the Royal Entomological

Society's Handbook (Ferrière & Kerrich, 1958), which is 34, corresponds with 50 names in the *Check List*. This difference is more than accounted for by a reduction in the number of Cleonymidae by 17. The work of R. D. Eady on the British Torymidae is well advanced, and in the subfamily Toryminae he now recognises 45 British species compared with the 66 in the *Check List*. The work of M. F. Claridge on the Eurytomidae will doubtless show a similar state of affairs.

Among the Pteromalidae, the Lamprotatinae of western Europe were studied by Delucchi (1954). Out of a total of 59 species recognised, no less than 43 were described as new in this or in a preliminary paper published a year earlier. The synonymy was not given in full; but Delucchi left only 12 valid British species as compared with a *Check List* total of 69. It is reasonable to suppose, however, that by further collecting, and especially by rearing from leaf-mining Diptera, the British total could be raised to about two-thirds of that for western Europe.

In revising the genus *Trichomalus,* the species of which are parasites of weevils, Delucchi & Graham (1956) recognised 24 western European species, of which four were new. For the 20 old species they had 80 old names. Graham, who revised the Walker material in a paper published earlier in the same year (1956), placed 43 Walker names in synonymy with one or other of 17 considered as valid.

A study of the Pteromalidae of Switzerland has now been promised by Delucchi.

Graham (1959) has recently published a synopsis of the British Eulophidae. He has excluded the Aphelinidae, which now are usually regarded as a separate family, and has not included the Tetrastichinae. He has introduced a number of species described on the continent to the British faunal list, but has deliberately excluded descriptions of any species new to science. He has keyed out 148 British species, to which 40 may be added for *Entedon, Pnigalio,* and a few other genera not treated, making a total of 188. This compares with a total of 304 species in the *Check List,* but this comparison must be regarded as approximate, since Walker often misplaced a species to subfamily among the Eulophidae. It is to the point to compare this total with that of 130 known to Thomson (1878) from Sweden.

The world species of Aphelinidae have been relatively well known owing first to the work of Mercet (1912) and then to the more recent studies by Compere (1931, 1936, 1955).

The European Trichogrammatidae were studied by Kryger (1919) and the European Mymaridae by the same author (1950). The British Mymaridae are being studied in a series of papers by Hincks (1950, 1952, 1959), who has discovered several species new to science.

For the determination of European Chalcidoidea generally, the volume on the Russian species by Nikol'skaya (1952) may be used.

In the Proctotrupoidea, our knowledge of two subfamilies is now on a sound basis. The Proctotrupinae, parasites of beetle larvae, were studied by Nixon (1938) who recognised 29 British species, of which six were new to science, and to which one further species has since been added. Hellén, who studied the same group in Finland, treated 26 species,[1] of which two were new to science. The species seem to be very widespread in Europe, for Hellén's total included all but eight of those listed by Nixon.

Much more recently, Nixon has studied the Belytinae (1957). He recognised 138 British species, which compared with a *Check List* total of 93, and which included 28 British species new to science.

The Platygasteridae, parasites of gall-midges, are being studied at Newcastle. This study is not yet far enough advanced for an assessment to be made, but it is certain that many species and some genera have yet to be recorded in Britain.

For the Cynipoidea, there is a modern revision of the world genera by Weld (1952). The European species of gall-causers and their inquilines have been rather much studied, especially owing to the attraction of rearing the insects from the characteristic plant galls, and it seems likely that not many very distinct species remain to be discovered in western Europe. Modern work has been mainly on three lines; the association of the alternate generations of oak-galling species that had been described as separate species, the separation of species upon characters of the adult insect, in cases in which very similar insects emerge from very distinct galls, which also are found among the oak-gallers, and the splitting of species aggregates in which even the galls may be very alike, as has been done among the rose-gallers.

The truly parasitic Cynipoidea are very much less well known, but work on them is in progress in Britain, Czechoslovakia and Japan.

The numbers of species known in any group in any region are likely to be revised considerably in an upward direction when much more work has been done on rearing the species. True, common and well-known hosts often do produce common and well-known parasites. But, on the other hand, many commonly caught species are seldom or never obtained by rearing; while some species, which can be obtained in large numbers by rearing, are seldom or never captured in the course of general collecting.

Studies of immature forms

Beirne (1941a) has written a systematic study on larvae of Ichneumonidae and Short (1952) one on those of Braconidae, and a very recent one on Ichneumonidae (1959). Iwata (1958) has made a study of the eggs of 233 species of Japanese Ichneumonidae, which would repay further consideration in the light of recent ideas on the classification of the family.

[1] I accept as valid species the forms so treated by Nixon and, for purpose of comparison, have treated the Finnish records in this way, although Hellén considered a few of these forms as variants.

Wherein Lies Difficulty in the Systematics of Hymenoptera parasitica?

Size of group

Whereas the number of described species of Coleoptera in the world is much greater than of described species of Hymenoptera parasitica, the number of recorded species in a relatively well-worked fauna, such as that of Great Britain, is considerably less, less than 4,000 British Coleoptera compared with over 5,000 Hymenoptera parasitica. As the fauna becomes better worked, a greater proportion of additional species is found in the Hymenoptera parasitica than in the Coleoptera. It is reasonable to think that the numbers of species occurring in the world are in about the same proportion as in Britain, *i.e.* about three species of Hymenoptera parasitica to every two beetles. The number of described species of beetles was long ago estimated to be about a quarter of a million. On the supposition that there are now well over 300,000 described beetle species, there would have to be half a million described species of Hymenoptera parasitica if we had caught up. But our knowledge of the Hymenoptera parasitica of the world is not catching up, it is getting further behind: the *Zoological Record* for 1955 contains nearly 100 pages devoted to Coleoptera and only 14 on Hymenoptera parasitica.

W. H. Ashmead once made a guess, about sixty years ago, that there were a million species of Ichneumonidae in the world. This guess still seems sensible to-day.

Complexity of group

The largest family of beetles is the Curculionidae, the weevils. It has been said that no two authorities agree on how they should be classified. Two at least of the families of Hymenoptera rival this in complexity, the Ichneumonidae and the Encyrtidae. A radical regrouping of the Ichneumonidae has been attempted of recent years (Townes, 1944, 1951). This was foreshadowed, in varying degree, in earlier works such as those of Seyrig (1934) and more especially Beirne (1941a) who, in consultation with J. F. Perkins, gave keys to subfamilies, tribes and, in some cases, genera for the larvae. The new classificatory categories were not defined for the adults until several years later, in a paper (Smith & Schenefeld, 1956) which the authors only claimed to be valid for the fauna of the state of Wisconsin. Townes & Townes, when revising the world genera and North American species of the tribe Tryphonini, were unable to define the subfamily Tryphoninae for the adults although they did so for the larvae. Although with experience the affinities can be appreciated, the subfamilies seem harder to define than the tribes. Students of the British fauna will be pleased to know that J. F. Perkins has, in press[1], a key to the subfamilies of British Ichneumonidae. He now recognises about twenty subfamilies compared with five of classical authors.

[1]Now published, October 1959.

Attempts to make further progress with the classification of the Encyrtidae are only just beginning.

Variability

In general, species of Hymenoptera parasitica are very variable. There is far greater plasticity in the characters than is usual in, say, the Aculeate Hymenoptera. The males nearly always have the characters more weakly developed than the females and thus are harder to separate. The Proctotrupoidea and Aculeata have clear species differences in the form of the male genitalia, but the Ichneumonoidea and Chalcidoidea have so far mostly been found wanting in this respect. Work on these lines continues, and species differences have been described in the Ichneumonidae; but not very many cases are known of species that are difficult to separate on external characters but which can be identified on the male genitalia.

In Ichneumonidae, I have generally found proportions of parts and relative lengths constant to within about one part of eight, except for very aberrant specimens. Thus, though there may be a good average difference in such proportion between species, the absolutes may overlap. Proportions must be measured with a micrometer, for they can be very deceptive. I once doubted the identity of a species, which was described as having the petiolar segment twice as long as broad. Later I was fortunate enough to obtain the loan of the unique type, on which that segment is 1·3 times as long as broad, which was within the range known to me. The species had been correctly identified on other characters.

Size range

In Ichneumonidae, a range in length of say 7 to 12 mm. is very usual, and a large specimen may be twice as long as a small one or more, especially in parasites of wood-borers. In general, the taxonomic characters are more weakly developed in the smaller specimens. It may happen, however, that the sculpture does not decrease so much as the absolute size and thus is relatively strongly developed in small specimens.

Colour variability

Colour characters adduced for species may or may not be valid, and have to be tested for each species by the study of a good series of specimens from different localities. Colour descriptions that seem to be valid for middle or southern Europe often are not so for Britain, where the damper climate produces darker forms. This applies even more to Ireland, and means that colour patterns need very careful interpretation.

A species has an essential structure, and an essential colour pattern, but one must discover by intensive study what that structure and that colour pattern are, and their variation within the species. A simple colour difference, such as the presence or absence of a pale mark on the scutellum, can provide a good difference between two closely related species, or may be alternative conditions within one species. When one has really discovered what the essential colour pattern of a species is and what its range of variation, one may be able to interpret an old colour description with confidence. A species may have a great range of colour variation, yet possess some apparently trivial colour character that seems to be constant. For example, I once received from one European specialist a manuscript name of a supposed new variety based on one colour character. Having discovered from the study of many specimens that this particular colour character was good specifically I asked to see the specimen on which the supposed new variety was based. Examination proved that it did indeed possess the two distinct structural characters by which I had previously separated the second species.

Alternation of generations

In oak-galling Cynipidae this has been developed to the extreme. There is a regular alternation of gamic and agamic generations. Each generation produces a different type of gall, and in almost all cases they have been described as different species or even placed in different genera.

In Ichneumonidae such alternation as occurs seems to be seasonal, and the difference between an early summer and late summer brood is slight. Where alternate hosts are used, only intensive field study can show whether two forms, emerging from different hosts at different times of year, are different but closely allied species or whether they are seasonal forms of one species. It is also necessary to know whether individuals, missing a late summer emergence, would emerge in the early summer of the following year or remain immature until the late summer. In the Braconid genus *Apanteles,* the evidence suggests that some species have an early summer brood whose members lay one or a few eggs in a small larval host, and a late summer brood acting as fully gregarious parasites of more fully grown larvae.

Association of Sexes

In some genera it has been found practicable to separate species on the characters of one sex only. In Hymenoptera parasitica this is usually the female, but sometimes the male. In such cases, isolated specimens of the 'wrong' sex cannot be determined at present.

In some groups there is considerable sexual dimorphism, *e.g.* in the Proctotrupoid family Diapriidae. In some cases the sexes can be associated by the study of characters common to both, but in others it is desirable to rear mixed broods. The outstanding example of such difficulty is in the subfamily Ichneumoninae and particularly in the genus *Ichneumon* itself. In this genus most males are black in colour, with the second and third segments of the gaster bright yellow, and with bright yellow marks on the face, scutellum and legs. They are very commonly found flying in high summer, but it is very difficult to separate even these conspicuous forms into species. The females are stouter in build, black in colour, with the second and third segments of the gaster red-brown, the legs marked with whitish or pale yellow, with white spots on the hinder segments of the gaster and on the scutellum, and with white-banded antennae. They are most freely taken when, after mating, they are hibernating under bark or in suitable grass-tufts: more rarely are they found flying or on flower-heads in autumn or early summer. The host relations are still extremely little known. Within the last 25 years *I. suspiciosus* Wesm. has been reared from Swift Moth larvae (Hepialidae), and it is supposed that other species are parasites of cutworms. Since the subfamily consists exclusively of solitary parasites of Lepidoptera, there is no question of obtaining mixed broods. It would seem necessary, therefore, first to rear the species from soil-dwelling Lepidoptera, and determine the host from the pupa and cast larval skin, then to rear fresh hosts in cages in some number, and introduce hibernated female *Ichneumon* species to them.

Genera rich in species

A number of genera, of which the Braconid genera *Apanteles* and *Aspilota* may be quoted as examples, are extremely rich in species, many of them very closely related. Such genera must be regarded as being in an active state of evolution, and are more difficult for systematic treatment than the evolutionarily older groups.

Sibling species and infra-specific forms

Through more intensive study, particularly in North America, of supposedly distinct but variable species, such units have in a number of cases been split into small complexes of sibling species (*e.g.* Mason, 1956). This can be done, from the study of the fauna of a whole continent, with greater assurance than may be assumed from the study of the fauna of western Europe only, and the indications are that progress on these lines will continue. Forms that cannot, with confidence, be attributed to any one of the siblings may then be determined as the aggregate old species.

The evidence for the splitting of aggregate species comes more often from the biological angle. Thus, in the Encyrtid genus *Anagyrus* Howard, for which an investigator failed to construct a key to even the few European species, and in which there is evidently a vast assemblage of closely related species in Africa, there is a species *kivuensis* Compere, described from the Belgian Congo. This species is rather inactive. Another form in Kenya, which has not yet been separated from *kivuensis* on morphological characters, is notably more active and is of greater use in controlling scale insects. Such units may perhaps best be called biological races, although this may merely mask our ignorance and cause confusion with a phenomenon that is better understood in some better known insects (see Thorpe, 1930).

The ultimate so far reached in this direction is with the Aphelinid genus *Aphytis* Howard, which has been the subject of intensive biological study in California on account of its great importance in the control of scale insects on citrus. When I was there in 1956, work was being directed to the production of a strain combining the superior powers of control of one form with the greater tolerance of cold nights possessed by another form. The systematist is faced with different forms exhibiting all levels of distinctness. Such work as was just quoted makes it very difficult to determine dead specimens in the museum to the complete satisfaction of the field worker. It means that infra-specific forms are being studied comparable to the cultivated strains of wheat; but the material is far more difficult for the systematist to deal with.

I quote Compere (1955, p. 271):

> "Those who work with living insects regard as discrete any unit that exhibits distinctness of any character whatsoever—functional, physiological, ecological, biological, or otherwise. Generally, units below the level of morphological species are screened out by means of some biological phenomenon. These biological units, whatever they may be—strains, races, varieties, subspecies, sibling species—cannot be disregarded. In applied biological control, the biological characters of a parasite may determine its value. From this it does not necessarily follow that they have a corresponding value in systematics (Flanders, 1953).
>
> "The systematic value of the biological characters in *Aphytis* is largely a matter of conjecture. Then, too, these characters are often unreliable. The same stock may exhibit one character in one phase or environment, and a different character in another phase or environment. Moreover, it is highly improbable that the greater number of species can ever be identified by biological methods. As a matter of fact, it is now impossible to repeat many of the original experiments with the living insects owing to loss of stocks of known parentage and the possibility that some stocks have become intermixed. Many of the lesser units are known now only by the biological phenomena that originally revealed them."

Good systematic work normally precedes good biological work even if only, in the case of organisms not of special economic importance, because the worker on living things naturally prefers species that can be identified. Thus he adds biological information to the available evidence, and this in turn places the systematics on a firmer foundation. The field worker and the museum systematist are seldom the same person. The museum systematist is selected, or selects himself, for his special skill, and in any event he is normally required to study in the museum far more species than he could hope to do seriously in the field. The field worker and museum systematist should, so far as possible, work hand in glove. This is fully realised, at least by the museum systematist. He has a background field knowledge, and tends mentally to recreate life in the dead specimens he studies. His training, for the past century, leads him to accept biological differences as being of potentially equal importance with those he can observe on dead specimens: indeed he regards structural differences as being the outward expressions of differences in the fundamental biological make-up of the animals. The ideal is attained when the two approaches can be combined by the same investigator. To-day, this ideal is realised more frequently than in the past, and this holds out good promise for the future.

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